

## Environmental Protection Agency

## § 86.1207–96

fueled, natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled heavy-duty vehicles.

(b) Three topics are addressed in this subpart. Sections 86.1206 through 86.1215 set forth specifications and equipment requirements; §§86.1216 through 86.1226 discuss calibration methods and frequency; test procedures and data requirements are listed in §§86.1227 through 86.1246.

[54 FR 14562, Apr. 11, 1989, as amended at 58 FR 16047, Mar. 24, 1993; 59 FR 48521, Sept. 21, 1994]

### § 86.1206–96 Equipment required; overview.

This subpart specifies procedures for testing of gasoline-fueled, natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled heavy-duty vehicles. Equipment required and specifications are as follows:

(a) *Evaporative emission tests.* Section 86.1207 specifies the necessary equipment.

(b) *Fuel, analytical gas, and driving schedule specifications.* Fuel specifications for emission testing and for service accumulation are specified in §86.1213. Analytical gases are specified in §86.1214. Evaporative testing requires vehicle operation on a chassis dynamometer. The driving cycle is specified in §86.1215.

[58 FR 16047, Mar. 24, 1993, as amended at 59 FR 48521, Sept. 21, 1994; 65 FR 59957, Oct. 6, 2000]

### § 86.1207–96 Sampling and analytical systems; evaporative emissions.

(a) *Testing enclosures*—(1) *Diurnal emission test.* The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with §86.1217–96. Interior surfaces must be impermeable and nonreactive to hydrocarbons (and to methanol, if the enclosure is used for methanol-fueled vehicles). The temperature conditioning system shall be capable of controlling the internal enclosure air temperature to follow the prescribed temperature versus time cycle as specified in §86.1233–96 and appendix II of this part, within an instantaneous tolerance of  $\pm 3.0$  °F of the nominal tem-

perature versus time profile throughout the test, and an average tolerance of 2.0 °F over the duration of the test (where the average is calculated using the absolute value of each measured deviation). The control system shall be tuned to provide a smooth temperature pattern that has a minimum of overshoot, hunting, and instability about the desired long-term ambient temperature profile. Interior surface temperatures shall not be less than 40 °F at any time during the diurnal emission test. To accommodate the volume changes due to enclosure temperature changes, either a variable-volume or fixed-volume enclosure may be used for diurnal emission testing:

(i) *Variable-volume enclosure.* The variable-volume enclosure expands and contracts in response to the temperature change of the air mass in the enclosure. Two potential means of accommodating the internal volume changes are moveable panel(s), or a bellows design, in which impermeable bag(s) inside the enclosure expand and contract in response to internal pressure changes by exchanging air from outside the enclosure. Any design for volume accommodation must maintain the integrity of the enclosure as specified in §86.1217–96 over the specified temperature range. Any method of volume accommodation shall limit the differential between the enclosure internal pressure and the barometric pressure to a maximum value of  $\pm 2.0$  inches of water. The enclosure shall be capable of latching to a fixed volume. A variable-volume enclosure must be capable of accommodating a  $\pm 7$  percent change from its “nominal volume” (see §86.1217–96(b)), accounting for temperature and barometric pressure variation during testing.

(ii) *Fixed-volume enclosure.* The fixed-volume enclosure shall be constructed with rigid panels that maintain a fixed enclosure volume, and meet the following requirements.

(A) The enclosure shall be equipped with a mechanism to maintain a fixed internal air volume. This may be accomplished either by withdrawing air at a constant rate and providing make-up air as needed, or by reversing the flow of air into and out of the enclosure in response to rising or falling

temperatures. If inlet air is added continuously throughout the test, it should be filtered with activated carbon to provide a relatively low and constant hydrocarbon level. Any method of volume accommodation shall maintain the differential between the enclosure internal pressure and the barometric pressure to a maximum value of  $\pm 2.0$  inches of water.

(B) The equipment shall be capable of measuring the mass of hydrocarbon and methanol (if the enclosure is used for methanol-fueled vehicles) in the inlet and outlet flow streams with a resolution of 0.01 gram per hour. A bag sampling system may be used to collect a proportional sample of the air withdrawn from and admitted to the enclosure. Alternatively, the inlet and outlet flow streams may be continuously analyzed using an on-line FID analyzer and integrated with the flow measurements to provide a continuous record of the mass hydrocarbon and methanol removal.

(2) *Running loss test.* The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with § 86.1217-96. The enclosure may be equipped with a personnel door, provided that the enclosure can still meet the requirements of § 86.1217-96 with the door installed. Interior surfaces must be impermeable and nonreactive to hydrocarbons and to methanol (if the enclosure is used for methanol-fueled vehicles). Interior surface temperatures shall not be less than 40 °F. If a running loss enclosure meets all the requirements of paragraph (a)(1) of this section, it may be used as a diurnal evaporative emission enclosure. The enclosure must contain a dynamometer that meets the requirements of § 86.1208. Provisions shall be made to remove exhaust gases from the enclosure. During the running loss test, ambient temperatures must be maintained at  $95 \pm 5$  °F ( $95 \pm 2$  °F on average). An air or oxygen cylinder with an attached self-contained breathing apparatus may be provided for the vehicle operator. The air required for vehicle operation shall be provided by one of the following methods:

(i) The running loss enclosure may be equipped to supply air to the vehicle, at a temperature of  $95 \pm 5$  °F, from sources outside of the running loss enclosure directly into the operating engine's air intake system. Supplemental air requirements (e.g., for an air pump) shall be supplied by drawing air from the engine intake source.

(ii) If it is shown to yield equivalent or superior results, the running loss enclosure may be designed with an air makeup system that brings outside air into the enclosure to accommodate the aspiration needs of the engine and any auxiliary devices. The makeup air shall be monitored to establish the background hydrocarbon levels (or hydrocarbon and methanol, levels, if applicable) of the makeup air. A filter may be used to provide dry air with a stable concentration of background hydrocarbon. The makeup-air vent shall be readily sealable for calibration of the enclosure and other purposes. For calculation of running loss emissions, it may be assumed that the hydrocarbon and methanol concentration in the air consumed by the vehicle is the same as that of the rest of the air in the enclosure.

(3) *Hot soak test.* The hot soak test may be conducted by holding the vehicle in an enclosure that meets the requirements for either diurnal emission or running loss tests. The enclosure shall be configured to provide an internal enclosure ambient temperature of  $95 \pm 10$  °F for the first 5 minutes, and  $95 \pm 5$  °F ( $95 \pm 2$  °F on average) for the remainder of the hot soak test.

(i) If the hot soak test is conducted in the same enclosure as the immediately preceding running loss test, interior surface temperatures shall not be below 70 °F for the last 55 minutes of the hot soak test.

(ii) If the hot soak test is not conducted in the same enclosure as the immediately preceding running loss test, interior surface temperatures shall not be below 70 °F for the duration of the hot soak test.

(b) *Evaporative emission hydrocarbon and methanol analyzers.* (1) For gasoline-, liquefied petroleum gas-, natural gas- and methanol-fueled vehicles a hydrocarbon analyzer utilizing the hydrogen flame ionization principle (FID)

shall be used to monitor the atmosphere within the enclosure (a heated FID (HFID)(235±15 °F (113±8 °C)) is recommended for methanol-fueled vehicles). Provided evaporative emission results are not affected, a probe may be used to detect or verify hydrocarbon sources during a running loss test. Instrument bypass flow may be returned to the enclosure. The FID shall have a response time to 90 percent of final reading of less than 1.5 seconds.

(2) For methanol-fueled vehicles, a methanol sampling and analyzing system is required in addition to the FID analyzer. The methanol sampling equipment shall consist of impingers for collecting the methanol sample and appropriate equipment for drawing the sample through the impingers. The analytical equipment shall consist of a gas chromatograph equipped with a flame ionization detector.

(3) The methanol sampling system described in paragraph (b)(2) of this section shall be designed such that, if a test vehicle emitted the maximum allowable level of methanol (based on all applicable standards) during any phase of the test, the measured concentration in the primary impinger would exceed either 25 mg/l or a concentration equal to 25 times the limit of detection for the GC analyzer, and such that the primary impinger collects at least 90 percent of the analyte in the samples. The remaining analyte shall be collected by the secondary impinger. The provisions of this paragraph apply to the design of sampling systems, not to individual tests.

(c) *Evaporative emission hydrocarbon and methanol data recording system.* (1) The electrical output of the FID used for measuring hydrocarbons (or hydrocarbons plus methanol, as appropriate) shall be recorded at least at the initiation and termination of each running loss and hot soak test, and at least at the initiation and termination of the enclosure sampling period(s) for the diurnal emission test, as described in § 86.1233. The recording may be taken by means of a strip chart potentiometric recorder, by use of an on-line computer system or other suitable means. In any case, the recording system must have operational characteristics (signal-to-noise ratio, speed of re-

sponse, etc.) equivalent to or better than those of the signal source being recorded, and must provide a permanent record of results. The record shall show a positive indication of the initiation and completion of each hot soak, running loss, or diurnal emission test (including initiation and completion of sampling period(s)), along with the time elapsed during each soak.

(2) For the methanol sample, permanent records shall be made of the following: the volumes of deionized water introduced into each impinger, the rate and time of sample collection and the chromatogram of the analyzed sample.

(d) *Fuel temperature control system.* Fuel temperatures of the test vehicle shall be controlled, as specified in § 86.1234(g)(1)(xv), with the following combination of fans. The control system shall be tuned and operated to provide a smooth and continuous fuel temperature profile that is representative of the on-road temperature profile. The running loss test configuration should be designed to avoid heating or cooling the fuel tank's vapor space in a way that would cause vapor temperature behavior to be unrepresentative of the vehicle's on-road profile.

(1) A vehicle cooling fan shall discharge air to the front of the vehicle. The fan shall be a road-speed modulated fan that is controlled to a discharge velocity that follows the dynamometer roll speed, at least up to speeds of 30 mph, throughout the driving cycle. If a warning light or gauge indicates that the vehicle's engine coolant has overheated, subsequent test runs on the that vehicle must include a vehicle cooling fan that follows the dynamometer roll speed at all speeds throughout the test cycle. The fan may direct airflow to both the vehicle radiator air inlet(s) and the vehicle underbody.

(2) An additional fan may be used to discharge airflow from the front of the vehicle directly to the vehicle underbody to control fuel temperatures. Such a fan shall provide a total discharge airflow not to exceed 8,000 cfm.

(3) Additional fans may be used to route heating or cooling air directly at the bottom of the vehicle's fuel tank. The air supplied to the tank shall be

between 85° and 160 °F, with a total discharge airflow not to exceed 4,000 cfm. For exceptional circumstances, manufacturers may direct up to 6,000 cfm at the bottom of the fuel tank with the advance approval of the Administrator.

(4) Direct fuel heating may be needed for canister preconditioning, as specified in §86.1232(j)(2). Also, under exceptional circumstances in which airflow alone is insufficient to control fuel temperatures during the running loss test, direct fuel tank heating may be used (see §86.1234-96(g)(1)(xv)). The heating system must not cause hot spots on the tank wetted surface that could cause local overheating of the fuel. Heat must not be applied directly to the tank's vapor space, nor to the liquid-vapor interface.

(e) *Temperature recording system.* A strip chart potentiometric recorder, an on-line computer system, or other suitable means shall be used to record enclosure ambient temperature during all evaporative emission test segments, as well as vehicle fuel tank temperature during the running loss test. The recording system shall record each temperature at least once every minute. The recording system shall be capable of resolving time to  $\pm 15$  s and capable of resolving temperature to  $\pm 0.75$  °F ( $\pm 0.42$  °C). The temperature recording system (recorder and sensor) shall have an accuracy of  $\pm 3$  °F ( $\pm 1.7$  °C). The recorder (data processor) shall have a time accuracy of  $\pm 15$  s and a precision of  $\pm 15$  s. Enclosures shall be equipped with two ambient temperature sensors, connected to provide one average output, located 3 feet above the floor at the approximate mid-length of each side wall of the enclosure and within 3 to 12 inches of each side wall. For diurnal emission testing, an additional temperature sensor shall be located underneath the vehicle to provide a temperature measurement representative of the air temperature under the fuel tank. For running loss testing, an ambient temperature sensor shall be located at the inlet to the fan that provides engine cooling. Manufacturers shall arrange that vehicles furnished for testing at federal certification facilities be equipped with temperature sensors for measurement of fuel tank temperatures. Vehicles shall be

equipped with two temperature sensors installed to provide an average liquid fuel temperature. The temperature sensors shall be placed to measure the temperature at the mid-volume of the liquid fuel at a fill level of 40 percent of nominal tank capacity. An additional temperature sensor may be placed to measure vapor temperatures approximately at the mid-volume of the vapor space, though measurement of vapor temperatures is optional during the running loss test. In-tank temperature sensors are not required for the supplemental two-diurnal test sequence specified in §86.1230-96.

(f) *Pressure recording system.* A strip chart potentiometric recorder, an on-line computer system, or other suitable means, shall be used to record the enclosure gage pressure for any testing in an enclosure, as well as the vehicle's fuel tank pressure during the running loss test and the outdoor driving procedure specified in §86.1229-85(d). Fuel tank pressure measurement and recording equipment are optional during the running loss test. The recording system shall record each pressure at least once every minute. The recording system shall be capable of resolving time to  $\pm 15$  s and capable of resolving pressure to  $\pm 0.1$  inches of water. The pressure recording system (recorder and sensor) shall have an accuracy of  $\pm 1.0$  inch of water. The recorder (data processor) shall have a time accuracy of  $\pm 15$  s and a precision of  $\pm 15$  s. The pressure transducer shall be installed to measure the pressure in the vapor space of the fuel tank.

(g) *Purge blower.* One or more portable or fixed blowers shall be used to purge the enclosure. The blowers shall have sufficient flow capacity to reduce the enclosure hydrocarbon and/or methanol concentration from the test level to the ambient level between tests. Actual flow capacity will depend upon the time available between tests.

(h) *Mixing blower.* Blowers or fans shall be used to mix the enclosure contents during evaporative emission testing. The inlets and outlets of the air circulation blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon

stratification. Maintenance of uniform concentrations throughout the enclosure is important to the accuracy of testing.

(1) *Diurnal emission test.* Blowers or fans shall have a capacity of  $0.8 \pm 0.2$  cfm per cubic foot of the nominal enclosure volume for mixing in the enclosure. Additional fans may be used to maintain a minimum wind speed of 5 mph (8 km/h) under the fuel tank of the test vehicle.

(2) *Running loss test.* Blowers or fans shall have a total capacity of at least 1.0 cfm per cubic foot of the nominal enclosure volume.

(3) *Hot soak test.* Blowers or fans must have a capacity of  $0.8 \pm 0.2$  cfm per cubic foot of the nominal enclosure volume. Circulated air shall not be aimed directly at the vehicle.

(i) *Point-source running loss measurement facility.* Some system requirements pertain specifically to running loss testing by the point-source method, in which emissions from potential sources are collected and routed to a sampling system. Emissions are sampled with the same equipment and techniques as for exhaust emission measurement. The test environment must contain a dynamometer that meets the requirements of § 86.108. During the running loss test, ambient temperatures must be maintained at  $95 \pm 5$  °F ( $95 \pm 2$  °F on average). An air or oxygen cylinder with an attached self-contained breathing apparatus may be provided for the vehicle operator.

(1) The running loss vapor vent collection system shall be configured to collect all running loss emissions from each of the discrete point sources that function as vehicle fuel system vapor vents, and transport the collected vapor emissions to a CFV- or PDP-based dilution and measurement system. The collection system shall consist of a collector at each vehicle vapor vent, lengths of heated sample line connecting each collector to the inlet of the heated sample pump, and lengths of heated sample line connecting the outlet of the heated sample pump to the inlet of the running loss fuel vapor sampling system. Up to 3 feet of unheated line connecting each of the vapor collectors to the heated sample lines shall be allowed. Each heated

sample pump and its associated sample lines shall be maintained at a temperature between 175 °F and 200 °F to prevent condensation of fuel vapor in the sample lines. The heated sample pump(s) and its associated flow controls shall be configured and operated to draw a flow of ambient air into each collector at a flow rate of at least 0.67 cfm. The flow controls on each heated sampling system shall include an indicating flow meter that provides an alarm output to the data recording system if the flow rate drops below 0.67 cfm by more than 5 percent. The collector inlet for each discrete vapor vent shall be placed in proximity to the vent as necessary to capture any fuel vapor emissions without significantly affecting flow or pressure of the normal action of the vent. The collector inlets shall be designed to interface with the configuration and orientation of each specific vapor vent. For vapor vents that terminate in a tube or hose barb, a short length of tubing of an inside diameter larger throughout its length than the inside diameter of the vent outlet may be used to extend the vent into the mouth of the collector. For those vapor vent designs that are not compatible with such collector configurations, the vehicle manufacturer shall supply a collector that is configured to interface with the vapor vent design and that terminates in a fitting that is capable of capturing all vapor emitted from the vent. The Administrator may test for running losses by the point-source method without heating sample lines or pumps.

(2) The running loss fuel vapor sampling system shall be a CFV- or PDP-based dilution and measurement system that further dilutes the running loss fuel vapors collected by the vapor vent collection system(s) with ambient air, collects continuously proportional samples of the diluted running loss vapors and dilution air in sample bags, and measures the total dilute flow through the sampling system over each test interval. In practice, the system shall be configured and operated in a manner that is directly analogous to an exhaust emissions constant volume sampling system, except that the input flow to the system is the flow from the

running loss vapor vent collection system(s) instead of vehicle exhaust flow. The system shall be configured and operated to meet the following requirements:

(i) The running loss fuel vapor sampling system shall be designed to measure the true mass of fuel vapor emissions collected by the running loss vapor vent collection system from the specified fuel vapor vents. The total volume of the mixture of running loss emissions and dilution air shall be measured and a continuously proportioned sample of volume shall be collected for analysis. Mass emissions shall be determined from the sample concentration and total flow over the test period.

(ii) The PDP-CVS shall consist of a dilution air filter and mixing assembly, heat exchanger, positive-displacement pump, sampling system, and associated valves, pressure and temperature sensors. The PDP-CVS shall conform to the following requirements:

(A) The gas mixture temperature, measured at a point immediately ahead of the positive-displacement pump, shall be within  $\pm 10$  °F of the designed operating temperature at the start of the test. The gas mixture temperature variation from its value at the start of the test shall be limited to  $\pm 10$  °F during the entire test. The temperature measuring system shall have an accuracy and precision of  $\pm 2$  °F.

(B) The pressure gauges shall have an accuracy and precision of  $\pm 1.6$  inches of water ( $\pm 0.4$  kPa).

(C) The flow capacity of the CVS shall not exceed 350 cfm.

(D) Sample collection bags for dilution air and running loss fuel vapor samples shall be sufficient size so as not to impede sample flow.

(iii) The CFV sample system shall consist of a dilution air filter and mixing assembly, a sampling venturi, a critical flow venturi, a sampling system and assorted valves, and pressure and temperature sensors. The CFV sample system shall conform to the following requirements:

(A) The temperature measuring system shall have an accuracy and precision of  $\pm 2$  °F and a response time of 0.100 seconds of 62.5 percent of a tem-

perature change (as measured in hot silicone oil).

(B) The pressure measuring system shall have an accuracy and precision of  $\pm 1.6$  inches of water (0.4 kPa).

(C) The flow capacity of the CVS shall not exceed 350 cfm.

(D) Sample collection bags for dilution air and running loss fuel vapor samples shall be of sufficient size so as not to impede sample flow.

(3) An on-line computer system or strip-chart recorder shall be used to record the following additional parameters during the running loss test sequence:

(i) CFV (if used) inlet temperature and pressure.

(ii) PDP (if used) inlet temperature, pressure, and differential pressure.

[58 FR 16047, Mar. 24, 1993, as amended at 59 FR 48521, Sept. 21, 1994; 60 FR 34358, June 30, 1995; 60 FR 43898, Aug. 23, 1995]

#### § 86.1213-08 Fuel specifications.

The test fuels listed in 40 CFR part 1065, subpart H, shall be used for evaporative emission testing.

[70 FR 40437, July 13, 2005]

#### § 86.1213-94 Fuel specifications.

Use the fuels specified in subpart N of this part for evaporative emission testing.

[71 FR 51487, Aug. 30, 2006]

#### § 86.1214-85 Analytical gases.

(a) *Analyzer gases.* (1) Gases for the hydrocarbon analyzer shall be:

(i) Single blends of propane using air as the diluent; and

(ii) Optionally, for response factor determination, single blends of methanol using air as the diluent.

(2) Fuel for the evaporative emission enclosure FID (or HFID for methanol-fueled vehicles) shall be a blend of  $40 \pm 2$  percent hydrogen with the balance being helium. The mixture shall contain less than 1 ppm equivalent carbon response. 98 to 100 percent hydrogen fuel may be used with advance approval by the Administrator.

(3) The allowable zero air impurity concentration shall not exceed 1 ppm equivalent carbon response.